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ABSTRACT

This document is intended to assist educators in the development of medical laboratory technician training programs. The following elements are included in the document: (1) an introduction; (2) the American Medical Technologists' Code of Ethics; (3) suggested curricula for medical laboratory technician programs for a 12-month course and an 18-month course; (4) model curricula for junior or community college programs; (5) synopses of selected medical laboratory subjects; (6) descriptions of competency-based, criterion-referenced certification examinations; (7) descriptions of the development and use of the medical laboratory practitioner competency outline; (8) outline of laboratory practitioner competencies (clinical chemistry, hematology, coagulation and hemostasis, immunohematology, immunology and serology, bacteriology, parasitology, and urinalysis); (9) quality and safety concerns in the clinical laboratory (quality control, proficiency testing, precautions against laboratory-related infections, laboratory safety, and Occupational Safety and Health Act requirements); (10) requirements for certification as a medical laboratory technician and medical technologist by American Medical Technologists; (11) settings eligible for approved laboratory experience; and (12) suggested reference material, including 4 items that introduce medical technology, 6 sets of review questions for medical technology, 5 references for general medical technology methodology, and 40 items of more specific subject matter. (CML)

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# GUIDE FOR TRAINING MEDICAL LABORATORY TECHNICIANS

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# GUIDE FOR TRAINING

# MEDICAL LABORATORY TECHNICIANS

Prepared by:

American Medical Technologists
Education, Qualifications, and Standards Committee

Fourth (1989) Edition

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## PREFACE

This guide has been prepared to assist educators in the development of medical laboratory technician(MLT) training programs. In addition to suggesting curricula for twelve-month and eighteen-month MLT training programs, this guide includes a detailed outline of the knowledge and skills required for successful performance as a laboratory practitioner.

The Accrediting Bureau of Health Education Schools(ABHES) is an agency which accredits private and proprietary postsecondary health education institutions. MLT training programs that conform to the Bureau's standards and incorporate the curricula outlined in this guide may become eligible for accreditation. Several "model" training curricula are presented here. It should be noted however, that these outlines are only suggestions. As such, the number of laboratory hours and lecture hours recommended should be considered flexible.

Also presented in this guide is a list of requisite laboratory competencies. This list outlines general laboratory knowledge domains in addition to specific task and knowledge areas in which the medical laboratory practitioner should be competent. This guide also discusses other salient medical laboratory issues that schools may wish to consider in program development. These issues include: proficiency testing, quality control, definition of "approved" laboratory experience, evaluation of student internship performance, and safety standards in the workplace. It is hoped that through thoughtful consideration of the guidelines presented here, schools may gain an additional perspective regarding medical laboratory technician program development.

American Medical Technologists acknowledges the following members of the Education, Qualifications, and Standards Committee for their assistance in the preparation of this guide:

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## INTRODUCTION

American Medical Technologists was founded in 1939, with the purpose of assuring competence in the clinical laboratory technology profession. With this aim, AMT has endorsed the development of training programs in private health career schools, vocational schools, and Junior and Community colleges. It is in the interest of providing adequately trained personnel (through the establishment of standardized training programs) that this guide has been prepared.

Professionals in the field of medical technology, in collaboration with educational institutions, must assume the responsibility for training and certifying practitioners entering the occupation. In addition, these agents are also responsible for the establishment and accreditation of appropriate training programs, and for norms of conduct within the profession. However, it is with the cooperation of all allied health personnel that AMT's goals will be attained. The delivery of quality health care is dependent upon the interrelationships of physicians, pathologists, nurses, laboratory technicians, as well as all other health personnel.

In terms of training, it is the responsibility of educators to instill in students, the discipline, intellectual integrity, methodological ability, and rules of conduct that befit members of the profession. With these aims, AMT offers a professional Code of Ethics (presented on the following page). Furthermore, upon completion of training in an approved educational setting, graduates may choose to obtain certification from American Medical Technologists. It is through association with AMT that clinical laboratory practitioners may stay informed of changes within the field. In addition, continuing education offered and tracked by the American Medical Technologists Institute for Education (AMTIE) will enable practitioners to maintain ongoing competency and technical proficiency throughout their careers.

Following the Code of Ethics, this guide addresses curricula and models for several MLT training programs. After a brief description of the nature of AMT certification examinations, a complete delineation of required laboratory knowledge and skills (on which the examinations are based) is presented. This guide also addresses a number of quality control and safety concerns in the clinical laboratory. The presentation is concluded by outlining the requirements for becoming certified as an MLT, describing settings eligible for "approved" laboratory experience, and listing a broad range of reference material.

Overall, it is suggested that this guide be used as a supplement to the ABHES Manual for Accreditation. The Manual outlines additional criteria that schools must adhere to, in order to have their medical laboratory technician training programs accredited.

# American Medical Technologists

## *Code of Ethics*

Recognizing that the American Medical Technologists seeks to encourage, establish and maintain the highest standards, traditions, and principles of our profession as a condition of Registration and maintaining membership in good standing in the American Medical Technologists, I pledge myself to practice Medical Technology in strict accord with the principles, standards, traditions and regulations of the American Medical Technologists and in accordance with the laws of the state in which I practice.

While engaged in the Arts and Sciences which constitute the practice of Medical Technology, I shall practice with thorough self-restraint, always placing the welfare of the patients, entrusted to my care for tests or examinations, above all else, with full realization of my personal responsibility for the patients' best interests.

Realizing that it is incumbent upon me, as a Medical Technologist to continually keep abreast of the times, I pledge myself to strive constantly to increase my technical knowledge of Medical Technology and to participate in the interchange of knowledge with other competent practitioners of Medical Technology and or other para medical Arts and Sciences that our joint knowledge shall benefit the profession and my practice.

I pledge accuracy and reliability in the performance of tests and to seek competent professional council when in doubt of my own judgment or competence in a particular test or examination.

As a further consideration for registration, I pledge myself to avoid dishonest, unethical or illegal compensation for such services as I shall render to the patients in my charge and I shall shun unwarranted professional publicity or unjust discrimination among the patients in my charge.

I pledge myself to protect the judgment of the attending physician in all cases in which I am directed to make laboratory tests or examinations, and to report the results of my findings free from all personal opinion to the attending physician only. I shall not make or offer a diagnosis or interpretation unless I be a duly licensed physician, except as the results of the report may of itself so indicate, or unless I am asked to by the attending physician.

I pledge myself to protect the identity and the integrity of all patients placed in my charge and to make only such reports public as shall be required by me by the laws of the state in which I practice or as the patient's physician shall direct.

As a final condition of Registration and Membership in the American Medical Technologists, I pledge my honor and my integrity to cooperate in the advancement and expansion, by every lawful means within my power, of the influence of the American Medical Technologists and to defend its principles.

## SUGGESTED CURRICULUM FOR 12 MONTH MEDICAL LABORATORY TECHNICIAN PROGRAMS

| SUBJECT | LECTURE HOURS | LABORATORY HOURS |
|---|---|---|
| Medical orientation | 10 | 10 |
| Medical ethics | 10 | 0 |
| Anatomy and physiology | 30 | 0 |
| General chemistry | 30 | 60 |
| Urinalysis | 20 | 40 |
| Gastric and duodenal analysis | 5 | 5 |
| Hematology | 60 | 140 |
| Bacteriology | 60 | 120 |
| Parasitology | 40 | 80 |
| Clinical chemistry | 80 | 160 |
| Serology (Immunology) | 30 | 70 |
| Immunohematology | 25 | 50 |
| ECG | 5 | 5 |
| Quality control | 10 | 20 |
| Quality assurance | 10 | 10 |
| Advanced laboratory procedures | 20 | 80 |
| | 445 | 850 |

The courses listed above equal 1,295 clock hours of training. Additional courses should be added to total 1,500 hours. For a one-year program, 232 school days (at 6½ hours per day) would equal 1,508 hours. It is suggested that a portion of the additional hours be devoted to an "Introduction to Instrumentation."

## SUGGESTED CURRICULUM FOR 18 MONTH MEDICAL LABORATORY TECHNICIAN PROGRAMS

| SUBJECT | LECTURE HOURS | LABORATORY HOURS |
|---|---|---|
| Medical orientation | 10 | 20 |
| Medical ethics | 10 | 0 |
| Anatomy and physiology | 60 | 0 |
| General chemistry (Inorganic) | 30 | 60 |
| Urinalysis | 40 | 75 |
| Gastric and duodenal analysis | 5 | 5 |
| Hematology | 60 | 140 |
| Advanced hematology | 19 | 60 |
| Bacteriology | 60 | 120 |
| Bacteriology (Advanced) | 16 | 55 |
| Parasitology | 48 | 96 |
| Clinical chemistry | 80 | 160 |
| Clinical chemistry (Advanced) | 20 | 75 |
| Serology (Immunology) | 30 | 70 |
| Immunohematology | 40 | 92 |
| Quality control | 15 | 20 |
| Quality assurance | 30 | 0 |
| Safety and Federal regulatory requirements | 10 | 0 |
| Advanced laboratory procedures | 40 | 80 |
| Virology and mycology | 10 | 10 |
| *Biology | 30 | 60 |
| *Zoology or embryology | 30 | 60 |
| *Chemical mathematics | 30 | 0 |
| *Communication skills | 20 | 0 |
| *Elementary physics | 20 | 32 |
| Optional courses | 40 | 64 |
| Laboratory supply & maintenance | | |
| Laboratory administration | | |
| Drugs of abuse and therapeutic drug monitoring | | |
| Instrumentation and automation | | |
| Computer use in the laboratory | | |
| | 818 | 1,399 |

The courses listed above equal 2,217 clock hours of training. Additional courses should be added to total 2,250 hours. For an eighteen-month program, 347 school days (at 6½ hours per day) would equal 2,255 hours. It is recommended that asterisked (*) courses be offered during the first six to eight months of the program.

## TWO MODEL CURRICULA SUGGESTED FOR MEDICAL LABORATORY TECHNICIAN PROGRAMS IN JUNIOR OR COMMUNITY COLLEGES

### MODEL I

#### FRESHMAN YEAR

| FIRST TERM | CR. | SECOND TERM | CR. |
|---|---|---|---|
| Anatomy and physiology I | 3 | Anatomy and physiology II | 3 |
| General chemistry I | 4 | General chemistry II | 4 |
| English I | 3 | English II | 3 |
| Technical mathematics | 3 | Statistics | 3 |
| Medical laboratory technology I | 3 | Medical laboratory technology II | 3 |
| Total credits | 16 | Total credits | 16 |

#### SUMMER TERM

| | |
|---|---|
| Technical report writing | 3 |
| Computer use in the laboratory | 4 |
| Total credits | 7 |

#### SOPHOMORE YEAR

| FIRST TERM | CR. | SECOND TERM | CR. |
|---|---|---|---|
| Microbiology | 3 | Medical laboratory technology IV | 6 |
| Medical laboratory technology III | 6 | Parasitology | 3 |
| Human relations and personnel problems | 3 | Hematology | 3 |
| Medical terminology | 3 | Elective | 3 |
| Total credits | 15 | Total credits | 15 |

## MODEL II

### FRESHMAN YEAR

| FIRST TERM | CR. | SECOND TERM | CR. |
|---|---|---|---|
| Physical education | 1 | Physical education | 1 |
| Communications | 3 | Medical terminology | 3 |
| Psychology | 3 | Social science elective | 3 |
| Chemistry I | 3 | Chemistry II | 4 |
| Biology | 4 | Anatomy and physiology I | 3 |
| Urinalysis | 4 | Serology | 3 |
| Total credits | 18 | Total credits | 17 |

### SOPHOMORE YEAR

| FIRST TERM | CR. | SECOND TERM | CR. |
|---|---|---|---|
| Anatomy and physiology II | 4 | Clinical chemistry II | 6 |
| Mathematics | 3 | Advanced lab procedures | 3 |
| Bacteriology | 4 | Parasitology | 4 |
| Hematology | 4 | Medical ethics and hospital orientation | 2 |
| Clinical chemistry I | 4 | Blood banking | 4 |
| Total credits | 19 | Total credits | 19 |

## MODEL III

### FRESHMAN YEAR

| FIRST TERM | CR. | SECOND TERM | CR. |
|---|---|---|---|
| Urinalysis/immunology | 4 | Hematology | 4 |
| General chemistry I | 4 | General chemistry II | 4 |
| Anatomy and physiology I | 4 | Anatomy and physiology II | 4 |
| Mathematics | 3 | Elective | 3 |
| English composition and rhetoric I | 3 | English composition and rhetoric II | 3 |
| Physical education and career planning | 1 | | |
| | 19 | | 18 |

### SUMMER CLINICAL PRACTICE
(12 weeks)

| | |
|---|---|
| Clinical practice I | 4 |
| Clinical practice II | 4 |
| | 8 |

### SOPHOMORE YEAR

| FIRST TERM | CR. | SECOND TERM | CR. |
|---|---|---|---|
| Immunohematology | 4 | Clinical chemistry | 4 |
| Bacteriology | 4 | Seminar | 3 |
| Social/behavioral science elective | 3 | Elective | 3 |
| Parasitology | 4 | Fundamentals of speech | 3 |
| | 15 | | 13 |

### SUMMER CLINICAL PRACTICE
(12 weeks)

| | |
|---|---|
| Clinical practice III | 4 |
| Clinical practice IV | 4 |
| | 8 |

## SYNOPSES OF SELECTED MEDICAL LABORATORY SUBJECTS

### MEDICAL ORIENTATION

In this introductory course, students become familiar with medical terminology used throughout the program. The following topics are addressed: the use and care of microscopes, incubators and other laboratory equipment, report slips, the importance of accurate reporting and filing, charts, sterilization, titrating, and the use, care, and cleaning of glassware. This course contains lectures on venipuncture, and teaches students to become proficient in the technique of drawing blood. Students are introduced to laboratory safety procedures, OSHA safety requirements, and state laboratory safety laws.

### MEDICAL ETHICS

This course addresses the ethical principles adopted by various allied health groups. A historical survey of professional ethics is presented. The following topics are addressed: law, property rights, disclosure and confidentiality, malpractice, and insurance.

### ANATOMY AND PHYSIOLOGY

This course presents an integrated approach to the structure and function of the human body. The skeletal, muscular, circulatory, respiratory, urinary, nervous, digestive, and reproductive systems of the body are addressed.

### GENERAL CHEMISTRY (INORGANIC)

The principles and theories of inorganic chemistry are presented in this course. The following are examples of the topics discussed: elements, compounds, atomic and molecular weights, valences, chemical reactions and equations, non-metals, water solutions, normal and standard solutions, acids, bases, salts, neutralization, indicators, titration, analytical principles, eqvivalent weight, oxidation and reduction, precipitation, filtration, and tests for metals. Special emphasis is applied to handling apparatus and chemicals in the laboratory, and general laboratory technique.

### CLINICAL CHEMISTRY (BASIC)

This course teaches students how to use and care for clinical apparatus and equipment. The analytical balance, colorimeter, spectrophotometer, and automated analyzer are examples of the equipment addressed. Students are also taught techniques for drawing blood samples, in addition to methods of handling and storing samples.

### CLINICAL CHEMISTRY (ADVANCED)

This course addresses the chemical constituents of blood and their relationships to health and disease. Students learn how to perform blood and other body fluid determinations accurately and efficiently. Macro and micro determinations are addressed. Quality control, and the influence of prescription drugs on laboratory test results are discussed.

URINALYSIS

Normal and abnormal constituents of urine are studied in this course. Macroscopic and microscopic urinalysis, chemical tests, urinary profiles in disease, special kidney function tests, urinary concentration and absorption tests, and pregnancy tests are addressed.

GASTRIC AND DUODENAL ANALYSIS

Gastric and duodenal constituents are studied in this course. Gastric residuum, methods of obtaining samples, test meals, fractional analysis, chemical tests for gastric and pancreatic ferments, occult blood, bile, and macroscopic and microscopic examination of gastric and duodenal contents are addressed. Students receive instruction regarding the preparation and handling of patients for these types of analyses.

HEMATOLOGY

This course addresses the cellular elements of blood and hematopoiesis. An introduction to blood coagulation is provided. Accuracy and quality control are emphasized throughout the course. The following are examples of the types of procedures and knowledge areas studied: use of blood pipettes, preparation of Wright's stain and diluting fluids, counting chamber theory, enumeration of red and white corpuscles, red and white blood cell counts, methods of hemoglobin estimation, red blood cell indices, relative and absolute differential counts, erythrocyte morphology, and bleeding time, particle counters and other blood cell enumeration instruments are studied. Other areas of study include: vital staining for reticulocytes, peroxidase reaction, platelet counts, red blood corpuscle fragility, macro and micro sedimentation rate methods, malarial parasites, pathologic blood profiles, anemia, polycythemia, sickle cell testing, leukocytosis, leukemia, infectious mononucleosis, purpura, hemophilia, regenerative and degenerative shifts to the left, hemograms and fragility tests.

ADVANCED HEMATOLOGY

In this advanced course, emphasis is applied to the study of anemias, leukemias, and other blood dyscrasias. Automation in hematology is discussed in greater depth. Other topics include: electrophoresis for hemoglobin and protein fractions, preparation and staining blood smears for malaria and other blood parasites, and problems in blood coagulation studies.

BACTERIOLOGY

This course addresses the morphology, staining, basic physiology, and medical significance of bacteria. Topics of study include: history of bacteriology, prevention and treatment of biological accidents, culture media, infection transmission, isolation, identification, and classification of bacteria, and sensitivity testing.

ADVANCED BACTERIOLOGY

In this course, emphasis is placed on the serological identification of bacteria, fluorescent antibody techniques, Rickettsial diseases, and automated sensitivity testing techniques.

PARISITOLOGY

This course addresses ova, cysts, and parasites found in urine, feces, and body tissue. Areas of study include: ova and parasite concentration methods, staining techniques, identification of organisms, flotation tests, and the collection and handling of specimens.

MYCOLOGY AND VIROLOGY

This course includes the study of human mycological infections and viral diseases. Students learn smear preparation, staining identification, and culturing (media and methods) of fungi such as: Actinomycetes, Norcardiosis, Coccidioidomycosis, North American Blastomycosis, Candidiasis, and Dermatophytosis. Viral diseases of the liver, respiratory tract, spinal fluid, skin, and brain are discussed. Immunological tests are addressed.

CLINICAL IMMUNOLOGY

Immunological principles are studied in this course. The following topics are addressed in this area of study: reading and reporting test results, graphing, reactions, spinal fluid tests, pregnancy tests, precipitation tests for infectious mononucleosis, serological tests involving the identification of bacteria and viruses, syphilis serology (VDRL, RPR, FTA), AIDS, and HIV.

IMMUNOHEMATOLOGY

This course addresses the following immunohematological topics: identification of blood and Rh groups, identification of ABO and Rh-Hr sub-groups, cross-matching, blood banking techniques, anti-$Rh_o$(D) IgG immunoglobulin, antigen-antibody response theory, isohemagglutination theory, detection and identification of irregular antibodies, and antiglobulin testing.

BIOLOGY

This basic course supplements study in bacteriology, parasitology, and other microbacteriological courses. Students study nomenclature, and cell structure (both macroscopically and microscopically).

LABORATORY MATHEMATICS

Arithmetic principles of use in the clinical laboratory are presented in this course. The following mathematical topics are addressed: decimals, percentages, proportions, and the metric and English systems. Students learn to perform calculations in areas such as solutions, dilutions, colormetrics, temperature, and pH. This course also includes an introduction to statistics.

LABORATORY SUPPLY AND MAINTENANCE

This course addresses the maintenance of laboratory equipment, supply inventory, reagent expiration, and storage of reagents and biologicals.

LABORATORY ADMINISTRATION

This course addresses job classification and assignment, personnel rotation and utilization, personnel relations, report filing, budgeting, supply ordering, and workload statistics.

DRUGS OF ABUSE AND THERAPEUTIC DRUG MONITORING

This course addresses qualitative and quantitative tests used for the detection of toxic materials in biological fluids and tissues.

(ALTERNATE COURSE CLASSIFICATION SCHEME)

MEDICAL TECHNOLOGY I

In this course, students learn medical terminology, and basic medical laboratory principles and concepts. Students apply this knowledge by performing, and reporting the results of routine quantitative and qualitative analyses.

MEDICAL TECHNOLOGY II

In this course, students learn the theory and principles of blood banking, and become proficient in procedures such as the following: ABO and Rh typing, crossmatching, irregular agglutinin detection, and the Coombs test. Students demonstrate the ability to perform procedures by analyzing and reporting the results of unknowns.

MEDICAL TECHNOLOGY III

In this course, students learn theories, principles, and procedures used in clinical chemistry. Basic laboratory methodology used for the determination of carbohydrates, lipids, proteins, electrolytes, and enzymes is presented. Other topics of study include: isotope methods, radial diffusion techniques, enzyme linked antibody techniques, assay thyroid testing, radioimmuno assay techniques, basic gastric and fecal analyses, and blood gases. Students demonstrate the ability to perform procedures by analyzing and reporting the results of unknowns.

MEDICAL TECHNOLOGY IV

In this course, students apply microbiological, immunological, and serological principles, and identify pathogens using chemical, immunological, and serological techniques. Concepts will be applied by testing body fluids and reporting results.

## COMPETENCY-BASED, CRITERION-REFERENCED CERTIFICATION EXAMINATIONS

### Competency-based Examinations

Competency-based examinations are comprised of a group of items selected to reflect the subject areas within a given field. Each item evaluates some aspect of a job-related skill or necessary knowledge.

AMT conducts research studies to determine which aspects of a medical laboratory practitioner's role should be evaluated on the examination. Such studies include task analyses of practicing technologists and technicians. A series of competencies are rated in terms of such dimensions as importance, time spent on task, and necessity of task knowledge. From these data, required laboratory skills are identified and organized into a competency outline that is the basis for preparing examinations. (The following section in this guide presents AMT's perspective on requisite competencies.)

### Criterion-referenced Examinations

All AMT examinations are criterion-referenced. As such, they are scored differently than typical tests that most people have taken.

Traditionally, most tests have been scored or graded "on the curve." To obtain an "A" an examinee was only required to perform better than the rest of the people in the group who took the test. Criterion-referenced examinations (such as those given by AMT) do not use the group for determining performance, but rather an external standard (called the "criterion"). Examinee performance is compared to this standard to determine if an individual's score is sufficiently high to indicate competence to begin working in the field as a professional.

Setting the Criterion. To determine the criterion or "passing score," each examination item is reviewed independently by experienced people in the field who indicate which responses a minimally competent individual should be able to eliminate as incorrect. The remaining plausible responses represent the "odds" that an individual (with only minimum acceptable knowledge) would have of selecting the "best choice" answer. For example, if the item raters determine that an examinee must select from among three plausible answers, the chances of selecting the correct answer are 1 out of 3, or .33. If the examinee must choose between two reasonable answers, then the odds of selecting the correct answer are 1 out of 2, or .50.

A team of experts reviews each item, indicating which of the four responses to each item the minimally competent examinee should be able to perceive as incorrect. The judges' ratings are pooled to obtain the minimum passing level (MPL) for each test item. To determine the passing score for the entire examination, the MPLs for each item are totalled.

All AMT examinations have 200 - 210 items, but consider the following hypothetical 5-item test.

| | Minimum Passing Level (MPL) |
|---|---|
| Item A | .50 |
| Item B | .33 |
| Item C | .25 |
| Item D | 1.00 |
| Item E | .50 |
| | 2.58 = Passing score, or MPL for test |

As shown in this example, item MPLs are added to yield the passing score for the entire test. Examinees with scores exceeding the test MPL pass the exam. Examinees with scores falling short of the test MPL fail the exam.

The advantage of a criterion-referenced examination is that the focus changes from the question "Is this individual better (or worse) than the group being tested?" to "Is this individual sufficiently competent, based on this examination, to be allowed to practice in the profession?"

## DEVELOPMENT AND USE OF THE MEDICAL LABORATORY PRACTITIONER COMPETENCY OUTLINE

American Medical Technologists administers "competency-based" certification examinations. A competency-based testing strategy involves assessing whether or not examinees possess the skills and knowledge required for successful performance in a particular role.

The first step in the development of this type of test is to define the relevant role by listing the areas in which a certificant (operationally defined as an examinee obtaining a passing score) must be competent. Such a list may include a variety of entries addressing knowledge of procedures, knowledge of theories, and applications of theories, in addition to a number of other knowledge and skill-related statements.

In the development of the Medical Laboratory Practitioner Competency Outline, the Education, Qualifications, and Standards Committee of American Medical Technologists began by constructing a draft of the document (the Committee is composed of a group of subject-matter experts, representing a variety of practical and academic settings). The preliminary list was then circulated to a random sample of medical laboratory practitioners to obtain their input. The competency outline presented on the following pages represents the consensus of experts and practitioners regarding the constitution of the laboratory role.

Once the list of competencies required for successful practice is developed, test questions addressing each competency (or general competency area) are written. The items are then classified in terms of a number of dimensions and entered into a computerized item bank. As the number of written test questions far exceeds the number of questions allowable on a particular paper-and-pencil test, examinations contain only a sample of items (therefore referencing only a sample of competencies). However, during test construction, the items are drawn from the bank in such a way as to assure that representative samples of competencies are assessed.

The outline presented on the following pages describes the knowledge and task areas considered by American Medical Technologists to comprise the role of the medical laboratory practitioner. The role is further differentiated by defining two distinct levels of laboratory practitioners: medical laboratory technician (MLT) and medical technologist (MT). The MLT may be considered an entry-level practitioner, while the MT tends to be a more experienced, supervisory-level practitioner. Each competency presented in the outline may be appropriate for either MLTs, MTs, or both groups.

Given the development of thorough and appropriate competency lists, and the selection of item samples adequately representing requisite competencies, valid tests for practitioner certification may be constructed. Through the employ of subject-matter experts, practitioner input, and extensive test validation research, American Medical Technologists works to reach this goal.

## OUTLINE OF LABORATORY PRACTITIONER COMPETENCIES

### CLINICAL CHEMISTRY

1. Know terminology related to clinical chemistry

| | |
|---|---|
| filtrate | skewness |
| supernatant | mean value |
| precipitate | percentage solutions |
| decant | delta O.D. |
| normal solution | end point chemistry |
| molar solution | rate analysis |
| equivalent weight | kinetic chemistry |
| wavelength | electrophoresis |
| liniarity | immunoelectrophoresis |
| accuracy | enzymes |
| precision | isoenzymes |
| reliability | electrolytes |
| trend | radioimmunoassay (RIA) |
| shift | enzyme immunoassay (EIA) |
| normal distribution curve | enzyme linked immunoassay (ELISA) |
| confidence limit | radial immunodiffusion (RID) |
| standard deviation | chromatography |
| coefficient of variation | fluorescence polorization immunoassay (FPIA) |
| bell curve | |

2. Know the designations and abbreviations used for weights and measures

3. Prepare solutions
   a) molar solutions
   b) normal solutions
   c) percentage solutions (w/w, w/v and v/v)

4. Know how to properly collect and handle blood specimens for analysis
   a) know the differences between serum, plasma and whole blood
   b) understand the precautions used in collecting blood samples
      1) know how to prevent hemolysis
      2) collect blood in proper collecting tubes for analysis (clotted blood, anticoagulant blood)
      3) use proper anticoagulants for each analysis performed
      4) know effects of using improper anticoagulants

5. Know how to handle and preserve body fluids for chemical analysis
   a) know types of urine preservatives and when they are used
   b) know cerebral spinal fluid analyses
   c) know how to analyze all other body fluids

6. Understand Beer's Law (Beer-Lambert Law)

7. Know tests related to the kidney
    a) know the kidney function tests
    b) perform the kidney function tests
    c) know the normal values of kidney function tests
    d) know the kidney clearance tests and their normal values

8. Know the anatomy of the liver
    a) know the liver function tests
    b) perform the liver function tests
    c) know the uses of liver function tests
        1) know which tests are elevated in liver disease
        2) know which tests are elevated in obstructive jaundice
        3) know which tests are elevated in hemolytic jaundice
        4) know the liver enzymes and isoenzymes

9. Know carbohydrates and carbohydrate metabolism
    a) know terminology related to carbohydrates

| | |
|---|---|
| carbohydrate | renal threshold |
| monosaccharide | glycogenesis |
| disaccharide | glycogenolysis |
| polysaccharide | glycolysis |
| glycogen | lipogenesis |
| ketones | insulin |

    b) name the uses of carbohydrates by the body
    c) know the types of glucose analysis tests
        1) know the tests for all carbohydrates and reducing substances
        2) know the true glucose tests (glucose specific)
        3) perform tests for glucose (blood, urine and spinal fluid)
    d) know the glucose tolerance test
        1) know the oral glucose tolerance test
        2) know the intravenous glucose tolerance test
        3) know a normal glucose tolerance curve
        4) know a diabetic glucose tolerance curve
        5) know a hypoglycemia curve (or flat curve)

10. Know proteins
    a) know functions of proteins
    b) know what makes up a total protein
    c) know the A/G ratio
    d) know body constituents made up of protein (hemoglobin, fibrinogen, enzymes, etc.)
    e) know the methods of total protein analysis, normal values, and principles of the tests
    f) know the methods of albumin analysis, normal values, and principles of the tests
    g) know the methods of globulin analysis, normal values, and principles of the tests
    h) know the principle of protein electrophoresis
        1) know the procedure for protein electrophoresis
        2) know the proper migration pattern of the plasma proteins
        3) know the electrophoretic patterns in disease

11. Know electrolytes
    a) know the cations and anions
    b) know electrolyte balance
    c) know the extracellular cations and anions
    d) know the intracellular cations and anions
    e) know the normal values of the cations and anions
    f) perform tests for anions and cations

12. Know carbon dioxide and carbon dioxide metabolism
    a) know and perform the different carbon dioxide tests ($CO_2$ content, $pCO_2$, $CO_2$ combining power)
    b) know normal values of carbon dioxide tests

13. Know the principles and tests related to blood gases
    a) know how to collect blood for blood gases
    b) know normal values

14. Know the minerals of the body and mineral metabolism

15. Know enzymes
    a) know methods of enzyme analysis
    b) know the enzymes of the pancreas and the tests used to determine the activities of these enzymes
    c) know the enzymes and isoenzymes of the heart and the tests used for these
        1) know the order in which enzymes and/or isoenzymes of the heart rise and return to normal
        2) know LDH1:2 flip
    d) know the enzymes and isoenzymes of the liver and the tests used for these
    e) know acid phosphatase and its use (know which parts of the body are rich in acid phosphatase)

16. Know the thyroid gland and its function
    a) know the thyroid function tests and their normal values
    b) know thyroid stimulating hormone and when it is performed

17. Know gout
    a) know the principle of the test for gout (uric acid)
    b) know the test for uric acid
    c) know the metabolism of purines in food and the formation of uric acid

18. Know special tests
    a) perform gastric analysis
    b) perform phenolsulfonphthalein test
    c) know principles of electrophoresis
    d) know therapeutic drug monitoring
    c) know tests for drugs of abuse
    f) know HDL, LDL, VLDL, cholesterol, triglycerides and other lipids

19. Know instrumentation
    a) know how to use a photoelectric colorimeter
        1) know the parts of the photoelectric colorimeter
        2) know the principle of the colorimeter

b) know how to use a spectrophotometer
   1) know the parts of the spectrophotometer
   2) know the principle of the spectrophotometer
   3) know the difference between a colorimeter and a spectrophotometer
   4) know how light waves are measured

c) know terminology related to light and wavelengths
d) calibrate a colorimeter and spectrophotometer
e) know how to use a flame photometer
   1) know the parts of the flame photometer
   2) know the principle of the flame photometer
   3) know what chemicals are analyzed by the flame photometer
f) know the atomic absorption spectrophotometer
   1) know the parts of the atomic absorption spectrophotometer
   2) know the principle of the atomic absorption spectrophotometer
   3) know the uses of the atomic absorption spectrophotometer
g) know the fluorescence spectrophotometer
   1) know the parts of the fluorescence spectrophotometer
   2) know the principle of the fluorescence spectrophotometer
   3) know the tests analyzed on the fluorescence spectrophotometer
h) know automated instrumentation
   1) know continuous flow analysis, the parts related to it, and its function
   2) know discrete analysis and the instruments utilizing this principle
   3) know the random access analyzer
i) perform daily, weekly and monthly maintenance on chemical analyzers
j) know the operation and principles of special analyzers
   1) radioimmunoassay (RIA)
   2) enzyme immunoassay (EIA)
   3) enzyme linked immunoassay (ELISA)
   4) nephelometer
   5) osmometer
   6) ultraviolet spectrophotometer
   7) fluorescence polorization immunoassay (FPIA)
k) know the use and maintenance of other laboratory instruments
   1) balance
   2) meters (pH meter and refractometer)
   3) blood gas apparatus
   4) electrophoresis apparatus
   5) automatic pipette
   6) burette

20. Perform all necessary quality control in the clinical laboratory
    a) know daily quality control and how to use the results
    b) know proficiency testing

21. Know the glassware and pipets used in the clinical laboratory, and the proper cleaning and maintenance of each instrument

## HEMATOLOGY

1. Know terminology related to hematology

| | |
|---|---|
| hematology | macrocytic |
| cells | microcytic |
| cytoplasm | normocytic |
| nucleus | normochromic |
| chromosomes | target cells (leptocytes) |
| cell membrane | sickle cells (drepanocytes) |
| protoplasm | acanthocytes and acanthrocytes |
| blood | Burr cells |
| serum | crenation |
| plasma | rouleaux |
| leukocytes | Cabot's Ring Bodies |
| erythrocytes | Howell Jolly Bodies |
| thrombocytes | Heinz Bodies |
| hematocrit | siderocytes and siderocytic granules |
| hemoglobin | spherocytes |
| specific gravity of blood | ovalocytes and elliptocytes |
| monopheletic theory | helmet cells |
| polypheletic theory | anemia and polycythemia |
| reticulocyte | hematopoiesis (hemapoiesis) |
| normal erythrocytes | extra medullary hematopoiesis |
| polychromatophilia | erythropoiesis |
| anisocytosis | myelopoiesis |
| poikilocytosis | lymphopoiesis |
| hypochromia | monopoiesis |
| hyperchromia | basophilic stippling |

2. Know the functions of the blood

3. Know the life cycle and life span of erythrocytes

4. Know the maturation series of an erythrocyte from its origin to its final destination in the peripheral blood stream

5. Know the formation of bilirubin from the destruction of erythrocytes

6. Perform manual red blood cell (erythrocyte) counts
   a) perform counts using red blood cell diluting pipette method
   b) perform counts using Unopette® method

7. Perform hemoglobin determinations
   a) perform determinations using hemoglobin pipette method
   b) perform determinations using Unopette® method

8. Perform hematocrit determinations
   a) perform macrohematocrit determinations
   b) perform microhematocrit determinations

9. Know tests used in the red blood cell (erythrocyte) indices
    a) know mean corpuscular volume (MCV)
    b) know corpuscular hemoglobin (MCH)
    c) know corpuscular hemoglobin concentration (MCHC)

10. Perform MCV, MCH and MCHC using mathematical formulas

11. Know the principles and uses of an erythrocyte sedimentation rate (ESR)

12. Know the types of ESRs (Wintrobe, Westigren, and Zeta sedimentation rates)

13. Perform each of the ESR procedures

14. Know the maturation series of the neutrophilic granulocytes

15. Know the maturation series of the granulocytic eosinophils and basophils

16. Know the maturation series of the nongranulocytes - lymphocytes

17. Know the maturation series of the nongranulocytes - monocytes

18. Know the maturation series of the thrombocytes (platelets)

19. Know the origin and significance of all granulocytes, lymphocytes and monocytes

20. Know the dimensions of the counting chamber and how to mathematically calculate leukocyte and erythrocyte counts

21. Perform manual leukocyte counts
    a) perform counts using white blood cell diluting pipette method
    b) perform counts using Unopette® method

22. Perform manual thrombocyte (platelet) counts
    a) perform counts using Rees-Echer method
    b) perform counts using Unopette® method

23. Know how to make a blood film (smear)

24. Stain blood films using Wright's, and Giemsa's stains

25. Perform WBC differential counts

26. Know how to perform leukocyte counts on very low counts and very high counts using the manual pipette method

27. Correct leukocyte counts in the presence of nucleated red blood cells

28. Know the principles of automated cell counters (Coulter principle and laser principle) and all cell counting parameters for automated cell counters

29. Perform reticulocyte counts

30. Perform direct eosinophile counts and Thorn tests

31. Perform sickle cell tests

32. Perform body fluid counts
    a) perform spinal fluid counts
    b) perform thoracentesis
    c) perform pleural fluid counts
    d) perform joint fluid counts

33. Perform Hansel stains on nasal secretions for eosinophiles

34. Perform sperm counts including examination for motility, morphological abnormalities, appearance and consistency

35. Know use and maintenance of related instruments
    a) microscope
    b) centrifuge
    c) glassware and pipets



# REQUIREMENTS FOR CERTIFICATION AS A MEDICAL LABORATORY TECHNICIAN AND MEDICAL TECHNOLOGIST BY AMERICAN MEDICAL TECHNOLOGISTS

## MLT® (AMT)

A medical technician or medical laboratory technician is a person qualified by education and experience to perform clinical laboratory testing requiring a limited exercise of independent judgment and discretion.

A technician ordinarily works only under immediate supervision, particularly when performing tests of other than routine nature. A technician may perform tests and report results of routine procedures without close supervision, but only if a technologist or other person of higher qualifications is on duty in the laboratory or on immediate call.

1. Applicant shall be of good moral character.
2. Applicant shall be a graduate of an accredited high school or acceptable equivalent.
3. All applicants for certification by AMT as an MLT must meet one of the following requirements:
   A. COLLEGE OR UNIVERSITY PROGRAM
      1) Applicant shall have completed at least two years (60 semester hours) of courses in an accredited college or junior college, including at least 25 semester hours in the sciences. This should include the following course requirements or the substantial equivalent, in any combination: 12 in chemistry, bacteriology, or parasitology; 3 in mathematics; 8 in biology, genetics, embryology, zoology, anatomy and/or physiology, plus 6 months of approved laboratory experience; or
      2) Applicant shall be the holder of an associate of science degree in medical technology (or equivalent) from an accredited junior college and shall have had 6 months of approved laboratory experience.
   B. GRADUATES OF PROFESSIONAL SCHOOL/ARMED FORCES SCHOOL
      1) Applicant shall be a graduate of a medical laboratory school accredited by the Accrediting Bureau of Health Education Schools. (18-month course followed by 6 months of approved laboratory experience or 12-month course followed by 12 months of approved laboratory experience, with the course requirements conforming to those required by the Accrediting Bureau of Health Education Schools); or
      2) Applicant shall have completed a course of at least one year (50 weeks) in a U.S. Armed Forces school of medical technology, followed by approved laboratory experience of such duration as will constitute a combined school and experience program of at least two years and with at least 6 months of such experience. The school courses must be the substantial equivalent of the courses and the laboratory experience required in B1 above.
4. Applicant shall take and pass the AMT registry examination for the certification of medical laboratory technician.
5. The AMT Board of Directors has further determined:
   A. Applicants holding other certifications obtained through examination in the medical laboratory technician category, determined by the AMT Board of Directors to have met the AMT training and experience requirements, may be considered for certification in AMT without further examination as medical laboratory technicians.
   B. Applicants holding certifications in other than the medical laboratory technician category as determined by the Board of Directors and having had at least two years of approved laboratory experience, will be considered for certification in AMT upon successful completion of the AMT certification examination for medical laboratory technician.

## MT®

A medical technologist is a person qualified by education and experience to perform clinical laboratory testing requiring the exercise of independent judgment and discretion.

1. Applicant must be of good moral character.
2. Applicant must be a high school graduate or acceptable equivalent.
3. All applicants for certification by AMT as an MT must meet one of the following requirements.
   A. COLLEGE OR UNIVERSITY GRADUATES
      1) Applicant must hold at least a bachelor's degree in medical technology or a bachelor's degree with a major in one of the biological, chemical, or physical sciences from an accredited college or university; and have a minimum of one year of approved laboratory experience.
      2) Applicant must have completed 90 semester hours in an accredited college. This can include junior college credit and must include 40 semester hours in the sciences. This should include the following course requirements or the substantial equivalent in any combination: 12 hours in chemistry; 12 hours in bacteriology and/or parasitology; 6 hours in mathematics; and 8 hours in biology, genetics, embryology, zoology, anatomy and/or physiology.
      In addition, all applicants must complete at least one year of approved laboratory experience.
   B. GRADUATES OF PROFESSIONAL SCHOOL/ARMED FORCES SCHOOL
      Applicant must meet the requirements for MLT and must have three (3) **additional** years of approved laboratory experience.
   C. Applicant is certified as an MLT (AMT) and has had three years of approved laboratory experience in **addition** to that required for MLT certification.
4. All applicants under 3A, B, or C above must take and pass the AMT registry examination for the certification of MT.
5. The AMT Board of Directors has further determined:
   A. An applicant may qualify for certification as a medical technologist on the basis of having graduated from an AMT approved school prior to November 1, 1965, having at least four years of approved laboratory experience, and successfully passing the AMT certifying examination for the certification of MT.
   B. Applicants who have passed the HHS (formerly HEW) CLT Proficiency Examination but who do not meet other qualifications for AMT certification will be eligible for AMT certification upon successful completion of the AMT MT certification examination.
   C. Applicants holding other certifications obtained through examination in the medical technologist category, determined by the AMT Board of Directors to have met the AMT training and experience requirements, may be considered for certification in AMT without further examination as a medical technologist.
   D. The AMT MT examination may be waived for an applicant who shall have taken and passed a medical technologist level examination reviewed by the Standards Committee and approved by the AMT Board of Directors.
   E. The AMT MT examination may be waived for an applicant who shall have taken and passed the HHS (formerly HEW) CLT Proficiency Examination and who shall have had at least five years of approved laboratory experience.

## COAGULATION AND HEMOSTASIS

1. Know the principle of hemostasis
2. Know the coagulation factors by Roman numeral and common name
3. Know the principle of, and how to perform prothrombin time (PT)
4. Know the coagulation factors that are tested for when performing prothrombin time (PT)
5. Know the principle of, and how to perform partial thromboplastin time (PTT or APTT)
6. Know the coagulation factors that are tested for when performing partial thromboplastin time (PTT)
7. Know the principle of, and how to perform capillary bleeding and clotting time
8. Perform Lee White coagulation time and know its uses
9. Perform Duke and Ivy bleeding time
10. Perform template bleeding time and know its uses
11. Know the principle of, and how to perform fibrinogen test
12. Know the principles of, and how to perform fibrin degredation product and fibrin split product test (FDP or FSP)
13. Know the principle of, and how to perform fibrin monomere test
14. Perform clot retraction test and know its uses

## IMMUNOHEMATOLOGY

1. Know terminology related to immunohematology

2. Know the principle of antigen-antibody reactions

3. Know the history of the ABO system and Rh system

4. Know the chemical structure of the H, A and B antigens

5. Know the antigens of the ABO system

6. Know the antibodies of the ABO system

7. Know the phenotypes and genotypes of the ABO system

8. Know the phenotypes and genotypes of the $Rh_o(D)$ system

9. Know antibodies
   a) know the five major immunoglobulins
   b) know which immunoglobulins or antibodies are important in the ABO and Rh systems
   c) know the natural antibodies
   d) know the 7S and 19S antibodies
   e) know bivalent or complete antibodies
   f) know univalent, incomplete, or blocking antibodies
   g) know Zeta potential
   h) know how the anti human globulin helps in detecting the blocking, univalent or incomplete antibody
   i) know how anti-human globulin (Coombs) is produced

10. Know the genetics of blood group antigen

11. Know the subgroups of A, and how they are tested for

12. Know what enzyme tests are used in immunohematology

13. Know comparisons of the Rh nomenclature of Fisher-Race, Wiener and Rosenfeld

14. Know the Du factor and how it is tested for
   a) know how to use the Du test in Rh typing
   b) know how to use the Du test in choosing donors for transfusions
   c) know how to use the Du test for blood recipients

15. Know the M and N systems

16. Know secretors

17. Perform direct or forward blood group slide and tube method

18. Perform reverse typing

19. Perform $Rh_o(D)$ typing slide and tube

20. Perform typing for subgroups of A

21. Perform genotyping

22. Know the principle of the antiglobulin (Coombs test)

23. Know the principle of the indirect antiglobulin (indirect Coombs) test

24. Perform indirect antiglobulin test

25. Know interpretations and uses of the indirect antiglobulin test

26. Know the principle of the direct antiglobulin (direct Coombs or DAT) test

27. Perform direct antiglobulin test

28. Know interpretations and uses of the direct antiglobulin test

29. Know the drugs responsible for red blood cell sensitization that cause a positive direct antiglobulin test

30. Perform and interpret the direct antiglobulin profile

31. Know the principle of the crossmatch procedure

32. Perform acceptable crossmatch procedure (anti-human globulin crossmatch) and interpret the results

33. Perform autocontrol test with crossmatch test, and know the reason for autocontrol

34. Perform Coombs control test and know the reason for the Coombs control test

35. Know errors that can occur in the crossmatch procedure (overmixing after centrifugation, improper washing of Coombs tube before addition of Coombs serum, etc.)

36. Know the principle of the $Rh_o(D)$ immune globin

37. Know the indications as to when, and to whom $Rh_o(D)$ immune globin should be given

38. Know the criteria used for declaring patients candidates for receiving $Rh_o(D)$ immune globin

39. Know cold agglutinins

40. Perform tests to detect cold agglutinins

41. Use procedures to eliminate cold agglutinins when they interfere with blood grouping and/or crossmatching of blood

42. Use tests to elute antibodies from red blood cells (heat elution and freeze elution)

43. Know blood donor requirements

44. Draw blood from donors

45. Perform therapeutic phlebotomies

46. Know all requirements for blood bank operation
    a) know how to visibly inspect units of blood daily
    b) know regulations for the disposition of blood bags and patient samples
    c) know policies for proper storage of blood and blood products for transfusion
    d) know procedures for transfusion reaction investigation
    e) know the blood components, their uses, storage requirements, and preparation

47. Perform quality control on all reagents

48. Keep proper records of all quality control and procedures including blood bank procedures.

## IMMUNOLOGY AND SEROLOGY

1. Know terminology related to immunology and serology

| | |
|---|---|
| treponema pallidum | thermostable |
| reagin | thermolabile |
| blood serum versus blood plasma | physiologic |
| inactivation | hypertonic |
| complement | hypotonic |
| antigen | cardiolypin |
| antibody | VDRL |
| hemolysis | PCT |
| amboceptor or hemolysin | RPR |
| anticomplementary | |

2. Know the principle of immunologic examination
   a) know antigen-antibody reaction
   b) know the relationship of T and B cells to antibody production

3. Know the definition of syphilis and the stages of infection

4. Know the types of serological tests for syphilis

5. Perform qualitative VDRL, RPR and PCT

6. Perform quantitative VDRL, RPR and PCT

7. Know the fundamentals of complement-fixation tests

8. Know how to test VDRL and RPR delivery needles for accuracy

9. Know quality control for all immunologic tests

10. Perform febrile agglutination tests

11. Know the differences between Weil Felix, Widal, and febrile agglutination testing

12. Know the theory of, and perform immunologic and serologic tests and procedures as required
    a) perform C-reactive protein (CRP)
    b) perform anti-Streptolysin screen and titer (ASO)
    c) perform heterophile agglutination
       1) perform heterophile quantitative with sheep cells, guinea pig, and horse serum absorption
       2) perform heterophile qualitative with latex agglutination or blood cell agglutination tests
    d) perform rheumatoid arthritis tests (latex agglutination)
    e) perform systemic lupus erythematosis (SLE or LE agglutination) tests
    f) perform red cell fragility (osmotic fragility) tests
    g) perform anti-nuclear antibody tests
    h) perform antigen detection of organisms in spinal fluid (Directogen® test and Bactogen® test)
    i) perform fluorescent antibody procedures
    j) perform group typing of bacterial growth

14. Know the principles of, and perform the test for radial immunodiffusion(RID)

15. Know cytomegaloviris, retrovirus, Epstein-Barr virus, and acquired immune dificiency syndrome (AIDS)

## BACTERIOLOGY

1. Know terminology related to bacteriology

| | |
|---|---|
| bacteria | osmosis |
| autotropic | semipermeable |
| heterotropic | cytoplasm |
| pathogenic | cell wall or membrane |
| flagella | nucleus |
| atrichous | spore |
| monotrichous | aerobic |
| lophotrichous | anaerobic |
| amphitrichous | faculatative anaerobic |
| peritrichous | faculatative aerobic |
| capsule | ambient |
| phagocytosis | |

2. Know the types of bacteria (shapes)

3. Know the growth curve of bacteria

4. Prepare culture media (blood agar, Mueller-Hinton and broth)

5. Know additives used in media preparations
   a) know enrichments
   b) know inhibitors
   c) know indicators
   d) know salts and buffers

6. Know the theory of staining procedure, and the preparation and uses of stains
   a) Gram's stain
   b) hot and cold acid-fast stains
   c) Giemsa and Wright's stains
   d) Albert's stain
   e) negative or relief stain
   f) spore stain
   g) capsule stain
   h) flagella stain
   i) India ink stain
   j) fluorescent stains
   k) methylene blue stain

7. Prepare bacterial smears and stain with Gram's and acid-fast stains

8. Examine stained smears

9. Know the uses of culture media
   a) bile esculin agar
   b) bismuth sulfite(BS)
   c) blood agar
   d) Bordet-Gengou
   e) brilliant green agar
   f) chocolate agar with V and X factors
   g) chopped meat glucose broth
   h) cornmeal agar
   i) cystine tellurite blood agar

j) desoxycholate agar
k) desoxycholate citrate agar
l) eosin methylene blue (EMB)
m) Fildes enrichment agar
n) hektone enteric agar
o) Loeffler's
p) Lowenstein Jensen (L-J)
q) MacConkey agar
r) mannitol salt agar
s) McBride medium
t) methyl red-Voges Proskauer medium (MR-VP)
u) Middlebrook 7H10
v) Petragnani
w) phenylethyl alcohol agar (PEA)
x) Sabouraud
y) Salmonella-Shigella agar (SS)
z) selenite F enrichment medium and tetrathionate broth
aa) SIM
bb) Simmons citrate
cc) Thayer-Martin chocolate agar
dd) thioglycollate broth
ee) triple sugar iron agar (TSI) and Kligler iron agar (KIA)
ff) urea broth
gg) various carbohydrates
hh) xylose lysine desoxycholate agar (XLD)
ii) SSA

10. Perform differentiating tests
    a) coagulase
    b) bile esculin (aesculin)
    c) bile solubility
    d) catalase
    e) oxidase
    f) optochin disc (P disc)
    g) bacitracin disc (A disc)
    h) beta lactam disk

11. Isolate and identify the gram-positive cocci and differentiate one from another

12. Isolate and identify the gram-positive bacilli and differentiate one from another

13. Isolate and identify the gram-negative cocci and differentiate one from another

14. Isolate and identify the gram-negative Enterobactereaceae and differentiate genera and species

15. Isolate, identify, and differentiate the nonfermenting gram-negative bacilli and the so-called miscellaneous gram-negative bacilli
    a) Pseudomonas
    b) Bordetella
    c) Hemophilis
    d) Brucella
    e) Campylobacter

16. Perform antimicrobial sensitivity testing (Kirby-Bauer, MIC, and automated systems)

17. Know various systems for bacterial identification (API, enterotube, automated systems, biochemical and carbohydrate systems)

18. Perform bacterial identification using biochemical and carbohydrate system

19. Culture specimens
    a) blood
    b) urine
    c) stool (feces)
    d) sputum
    e) throat
    f) spinal fluid
    g) urethral/cervical
    h) other body fluids

20. Perform concentration methods for sputum specimens to be cultured for acid-fast bacilli

21. Concentrate and culture sputums for acid-fast bacilli

22. Examine smears for acid-fast bacilli

23. Type cultures using type specific typing sera

24. Perform routine mycology procedures
    a) KOH preparation
    b) methylene blue staining
    c) lacto-phenol cotton blue staining
    d) culture using Sabaroud agar
    e) use germ tube
    f) use cornmeal agar
    g) India ink preparation

25. Perform special tests
    a) group A streptococci
        1) rapid enzyme immunoassay test (or other antigen detection kits) from throat swabs
        2) cultures for beta hemolysis screening
    b) Clostridium difficile toxin test

## PARASITOLOGY

1. Know terminology related to parasitology

2. Know the types of parasites and the descriptions of each (protozoa, helminthes)

3. Know the classification of parasites

4. Know the types of examinations for parasites and perform them
    a) feces
        1) macroscopic examination
        2) microscopic direct saline and iodine preparations
        3) various concentration methods
    b) blood
    c) urine
    d) other body fluids
    e) tissue

5. Examine specimens, direct and concentrated methods for intestinal parasites
    a) Protozoa
    b) Trematodes
    c) Cestodes
    d) Nematodes

6. Perform tests for blood parasites
    a) malaria
    b) filaria
    c) trypanosomes

7. Prepare Sudan IV stain for fats

8. Examine stool for fats

9. Perform test for occult blood in stool

10. Prepare and stain permanent smears for ova and parasites using the iron hematoxylin and trichrome methods

11. Know what the cryptosporidium species are, and how to identify and stain them

12. Know concentration methods for identifying intestinal parasites

## URINALYSIS

1. Know terminology related to urinalysis

2. Know the formation of urine

3. Know the anatomy of the kidney

4. Know the physical properties of urine

5. Know the chemical properties of urine

6. Know the microscopic structures found in urine

7. Perform urinalysis consisting of physical, chemical, and microscopic findings

8. Relate abnormal urinary findings to disease states

9. Perform individual chemical tests on urine

10. Know how to collect urine specimens
    a) random specimen
    b) midstream specimen
    c) catheterized specimen
    d) timed specimen (2, 12, 24 hr.)

11. Know the principles of urine tests
    a) specific gravity
    b) Ph
    c) protein
    d) glucose
    e) ketones
    f) occult blood
    g) leukocyte esterase
    h) nitrate
    i) bilirubin
    j) urobilinogen

12. Know special tests
    a) Addis count
    b) Ehrlich's test for urobilinogen
    c) Fishberg concentration and dilution
    d) Fantus test for chloride
    e) Gerhardt's diacetic acid test
    f) Gmelin's test for bilirubin
    g) Harrison's test for bilirubin
    h) heat and acetic acid test for protein
    i) Heller's ring test for albumin
    j) Ictotest® (Ames) for bilirubin
    k) Lang's nitroprusside test for acetone
    l) Linderman's test for diacetic acid
    m) Mosenthal's concentration test
    n) Robert's test for acetone
    o) Rother's test for acetone
    p) Smith's test for bilirubin

q) sulfosalicylic acid test for protein
r) Sulkowitch test for calcium
s) test for indican Obermeyer's
t) Watson's test for porphyrins
u) Watson - Schwartz test for porphyrins

13. Know the names and descriptions of the blood cells found in urine

14. Know the names and descriptions of the types of epithelial cells found in urine

15. Know the descriptions and definitions of casts found in urine

16. Know how, and where casts are formed

17. Know the causes of each type of cell and cast found in urine

18. Know the types of crystals found in urine

19. Know the descriptions of pathological crystals found in urine

20. Know amorphous and its significance in urine

21. Know mucus and its significance in urine

22. Know the descriptions of, and identify parasites in urine

23. Know the description of spermatozoa, and their significance in urine

24. Know the descriptions of bacteria, and their significance in urine

25. Know the principle of, and perform urinary pregnancy tests

26. Know the description of cylindroids and their significance in urine

27. Know and perform the Bence Jones protein test

## QUALITY AND SAFETY CONCERNS IN THE CLINICAL LABORATORY

### Quality Control

1. Establish and maintain quality control parameters
2. Prepare quality control charts and graphs
3. Calculate means, standard deviations, and coefficients of variation
4. Recognize trends, shifts, and "out of control" situations
5. Remediate "out of control" situations
6. Recognize bias in control systems
7. Maintain and update (annually) quality control procedure manual

    a) laboratory policies
    b) laboratory organization and personnel definition
    c) procedure for collection, labeling, and transportation of specimens
    d) work sheets, log books, and reporting of results
    e) instructions for processing specimens
    f) laboratory safety (biological, chemical, mechanical, and electrical hazards, and the disposal of contaminated materials)
    g) monitoring quality control of equipment, media, reagents, and stains

### Proficiency Testing

1. Know rules and regulations regarding proficiency testing

    a) acceptable parameters for constituents
    b) laboratory areas addressed by proficiency testing
    c) rules of inspecting agencies and Medicare-approved systems

2. Know blind and double-blind studies
3. Compare peer results
4. Know source of proficiency testing materials
5. Know procedure for processing proficiency testing material

### Precautions Against Laboratory-related Infections

1. Know current universal precautions criteria
2. Know laws pertaining to laboratory waste disposal
3. Know laws pertaining to disposal of sharps
4. Know principles of asepsis and contamination
5. Know methods of sterilizing and disinfecting contaminated areas
6. Wear protective gloves, gowns, and masks, and use hoods and glove boxes
7. Observe safety precautions regarding infection

    a) protect cuts or abrasions from patient body fluids
    b) avoid cuts by broken glass
    c) avoid accidental pricks by used needles
    d) wash hands with disinfectant soap when exposed to infection
    e) handle blood specimens and other body fluids appropriately
    f) label and store reagents, acids, and bases appropriately
    g) store flammables appropriately

**Laboratory safety**

1. Use protective and preventative equipment

    a) gloves, aprons, lab coats, and glasses
    b) chemical cabinets and explosion-proof refrigerator
    c) safety step ladder
    d) eye and face wash, shower
    e) fume hoods
    f) safety cans
    g) rubber and asbestos gloves
    h) skin cream
    i) respirators (vapors, dust, fumes)
    j) safety shields

2. Know hazards

    a) fire
    b) electrical
    c) chemical
    d) biological
    e) radioactive

3. Know equipment and procedures for managing hazards

    a) fire extinguishers
    b) fire blanket

**OSHA Requirements**

1. Know regulations regarding the grounding of electrical equipment
2. Know regulations regarding waste disposal
3. Know procedure for cleaning of contaminated areas
4. Know how to complete OSHA reporting forms and incident forms

**SETTINGS ELIGIBLE FOR APPROVED LABORATORY EXPERIENCE**

All laboratory experience credited toward AMT certification must be in a laboratory which performs chemical, physical, biological, histological or cytological examination of various body fluids and tissues. Experience may be obtained in one or more of the following settings:

1. In a Clinical Laboratory meeting one of the following requirements:
   a. Directed by a physician licensed as a Medical Doctor (MD) or Doctor of Osteopathy (DO).

   b. Directed by a person holding an earned doctorate degree in one of the sciences.

   c. Approved for service to patients under "Conditions for Coverage of Services of Independent Laboratories" under Medicare, or

2. In a Research Laboratory meeting one of the following requirements:
   a. Operated by an accredited college or university.

   b. Directed by the holder of an earned doctorate degree, or

3. In a Hospital Laboratory meeting one of the following requirements:
   a. Accredited by the Joint Commission on Accreditation of Health Care Organizations.
   b. Accredited by the Bureau of Hospitals of the American Osteopathic Association.

   c. Accredited by an agency approved by Medicare.

Regardless of training setting, the laboratory experience should have covered at least four(4) of the various branches of clinical laboratory testing (e.g. chemistry, hematology, parasitology, urinalysis, bacteriology, serology, blood banking, etc.).

Approved Laboratory Experience

American Medical Technologists recognizes graduates of training programs in medical laboratory techniques from schools accredited by the Accrediting Bureau of Health Education Schools, the Armed Forces programs (a minimum 50 weeks' duration), and junior colleges as candidates for certification as medical laboratory technicians.

Upon completion of their training, applicants taking and passing the registry examinations become members-elect of the AMT. When they successfully complete one year of experience in an approved laboratory, they become full MLT members of AMT.

Proper simulated clinical laboratory experience in the academic setting prepares a student to become a productive member of the laboratory within a short period of time, with a minimum of training and effort on the part of the laboratory staff.

The laboratory director or supervisor should be aware that this is probably the graduate's first experience in an actual clinical laboratory.

Every effort to properly orient the worker should be employed, not the least of which is patience and understanding on the part of the laboratory staff.

The following training outline is presented for your consideration. The outline may be altered to suit your particular needs.

It is important to utilize some system of evaluation during the year when the medical laboratory technician first gains laboratory experience.

Properly instituted and implemented, successful orientation will benefit employer, employee and the laboratory.

1. The new medical laboratory technician will feel more at ease if he is not immediately expected to perform as an experienced laboratorian.

2. Cooperation and assistance from the staff will instill confidence.

3. Honest evaluation of his ability, as regard to the accuracy and the technical proficiency with which tests are performed, will instill pride in his work and respect for the laboratory and its personnel.

Rotation should be based on exposing the worker to the major areas ("departments") of medical technology.

| | | |
|---|---|---|
| 1. | General Orientation | 1 week |
| 2. | Hematology | 5 weeks |
| 3. | Chemistry | 8 weeks |
| 4. | Urinalysis | 2 weeks |
| 5. | Blood Banking | 4 weeks |
| 6. | Serology | 2 weeks |
| 7. | Microbiology | 8 weeks |

After this period of orientation, the medical laboratory technician is assigned duties by the laboratory director or supervisor as they deem necessary for the remaining 22 weeks of the year.

The following should be included in a thorough orientation:

1. Introduction to laboratory staff, hospital staff.

2. A discussion of the rules and regulations regarding the laboratory and the hospital.

3. Introduction to the general routine of the laboratory, familiarization with general conduct of each department, and the available equipment.

4. A discussion of the techniques utilized in phlebotomy: when, how, and by whom blood is collected. The technician should be allowed to observe blood collections and to collect blood.

5. Information regarding handling requisitions and charting results.

6. Familiarization of the technician with supply room, method of inventory maintenance, and general housekeeping procedures required of the staff.

The following points should be addressed as a worker is rotated through <u>each</u> department:

1. General orientation to the area or department.

2. Handling of specimens: type of requisition used.

3. How work is allocated in each department.

4. Methods employed: procedure manuals should be made available.

5. Equipment utilized: operation of automated equipment.

6. Location of supplies and glassware.

7. Quality control program, if applicable: explanation of program, maintenance, reporting.

8. How to handle stat requests.

9. Charting and reporting results.

It is recommended that, during the first few days in each area, the technician's work on specimens be analyzed by experienced personnel and the results compared. Areas of weakness should be pointed out, and probable areas where errors might occur should be discussed.

Whenever a new procedure or instrument is introduced, the technique employed by the technicain doing the procedure or handling the equipment should be observed. Test results should be carefully checked.

Once a week, for the first few weeks in each department, a conference with the technician and the director, supervisor, or technologist in charge of the department should be held. An evaluation should be made on the week's work. Areas of weakness should be pointed out. Observations of other members of the laboratory staff should be recorded.

A record of the progress of the technician should be maintained.

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